Below are the U.S. Nuclear Regulatory Commission (NRC) staff talking points on the Homestake Mining Company of California (HMC), Grants Reclamation Project (GRP) Alternate Concentration Limit (ACL) License Amendment Request (LAR), dated August 8, 2022.

The NRC staff notes that the first number of the comment below corresponds to the chapter or section in the ACL LAR where the comment originates.

Comment 1-1 (Institutional Controls)

The LAR does not provide information regarding the transfer of property and structures within the proposed control boundary including:

a. The status and schedule for acquisition of the 166 parcels out of the 522 that have not been acquired.
b. The disposition of above ground structures, such as existing single-family homes, ancillary structures, and additional onsite materials.
c. The disposition of below ground existing infrastructure on individual parcels, for example, septic tanks, drain fields, and groundwater wells.
d. A discussion and plan for existing roads, road maintenance, or road removal, if required, and discussions with the governmental agency that controls existing roads.
e. A discussion and plan for any public water lines that exist within the proposed control boundary and discussions with the governmental agency that controls existing public water lines.
f. A discussion and plan for any electric utilities that exist within the proposed control boundary and discussions with the utility that controls existing electric lines.
g. A discussion and plan for any rights-of-way, public land or additional infrastructure that may exist in the proposed control boundary.
h. A discussion of the durability and enforceability of the 2018 State of New Mexico Order that restricts the permitting and drilling of wells for new appropriations, or replacement or supplemental wells, and restricts the permitting of any change to the point of diversion of any existing wells within the boundaries defined and as shown in ACL application Figure 1.2-56.
i. A discussion of the use of groundwater from the San Andres-Glorieta aquifer (SAG) within the proposed control boundary and if use of groundwater from the SAG within the control boundary can be fully restricted based on HMC's effort to acquire land ownership.

Discussion

The proposed control boundary for this ACL application increases the total acreage of the boundary from approximately 1,200 acres to over 6,000 acres. There are currently 522 parcels in this expanded area, and HMC currently owns 356 of these parcels, which is about 84 percent of the land area. This area has a variety of owners including residential, commercial, and other government entities. Based upon the application, additional information will be required to assess the ownership interests HMC is obtaining (surface versus subsurface, quit claim deed versus warranty deed, restrictions, and other potential leases and licenses) from these various owners. HMC should provide information on the protectiveness, durability, viability, and liabilities attendant to the overall land ownership by HMC within the proposed control boundary and how that could and will be managed in the long-term.

HMC states it will not allow use of groundwater on any land it owns within the control boundary for any purpose and HMC intends to provide demonstration of this effort to acquire the land ownership to NRC prior to final approval of this amendment request. If ownership cannot be obtained, it is unclear how access to groundwater can or will be restricted. The 2018 State of New Mexico Order is only intended to restrict groundwater use from the alluvial and Chinle aquifers and considering that New Mexico could rescind the order at any time, its durability is uncertain. There is little discussion of control and restriction of SAG water use within the proposed control boundary.

Comment 1-2 (Institutional Controls)

The LAR does not contain a commitment from the proposed long-term care custodian to take land within the proposed control boundary, including the land between the point of compliance (POC) and distant point of exposure (POE) that is in excess of the land used for disposal of byproduct material.

Discussion

Due to the complexities of the number of properties in the proposed control boundary, a general statement that an applicant will acquire control on all properties or provide a demonstration of the effort to acquire land ownership, is insufficient and the NRC staff needs to treat the proposed POE(s) as a “distant” POE(s).

Written assurance is needed stating that the appropriate Federal or State agency will accept the transfer of the proposed property, including land in excess of what is needed for the tailings disposal (see NUREG 1620 Section 4.3.3.2 (5)). Alternate concentration limits may not be established at sites involving a distant POE until the licensee agrees to transfer the title to the land, and the appropriate Federal or State government commits to take such land, including the land between the POC and POE that is in excess of the land used for disposal of byproduct material. In this ACL application, HMC uses the control boundary to represent the groundwater POE (see ACL Section 4.2.4.3 and 4.3.2.1.1). Assurances are needed from the long-term care custodian to accept the nearly 6,000 acres of land contained within the proposed control boundary. Because of the complexity of the site (e.g., widespread contamination across multiple aquifers, multiple regulatory agencies), the risk significance of the site (e.g., proximity of contamination to potential receptors), and the uncertainty of modeling of the site (e.g., limited support for key modeling assumptions such as precipitation, recharge, contaminant transport), an agreement with the appropriate agency may require a significant amount of time.

Comment 1-3 (Precipitation – Annual Rates)

The assumed precipitation rates do not appear to be consistent with historical precipitation rates and provide for uncertainty when associated with climate change projections.

Discussion

In the ACL application, HMC cited meteorological data from the Grants-Milan Municipal Airport from 1986 through 2018 with an average annual precipitation of 13.6 in/year. However, in the ACL application for the base case condition in the groundwater model, HMC assumed an average precipitation of 10.6 inches/year varied linearly over 200-year cycles from a low of approximately 8.9 inches/year to a high of 12.3 inches/year. In the bounding case condition, HMC assumed an average precipitation of 11.7 inches/year varied linearly over 200-year cycles from a low of approximately 8.9 inches/year to a high of 12.8 inches/year. Figure 1 below shows HMC’s assumed precipitation for the base case and bounding case conditions, as well as a decreased precipitation case. The values assumed in the groundwater model appear to be more consistent with HMC's GRP meteorological data.

NRC staff is concerned with the significant discrepancy between the reported precipitation from the Grants-Milan Municipal Airport and HMC's GRP meteorological data (i.e., 44% higher annual precipitation at Grants-Milan Municipal Airport than GRP), which are located approximately 5 miles apart. Several factors (e.g., exposure and wind, rain gauge design and evaporation) could be biasing HMC's meteorological data low.

The NRC staff reviewed the Western Regional Climate Center (WRCC) data for Grants, NM, which HMC also relied upon. For the period from 1986 to 2022, annual precipitation averaged 13.5 in/year with a maximum annual value of 19.0 in/year (https://wrcc.dri.edu/cgi-bin/rawMAIN.pl?nmXGRA), as shown in Figure 2. These precipitation rates from the Grants-Milan Municipal Airport are plotted against HMC's projected precipitation rates for the proposed base case, bounding case, and decreased precipitation case in Figure 3 below.

The NRC staff is concerned that HMC selected a range of precipitation rates for the base case and bounding case conditions that was generally less than the recent precipitation rates from 1986 to 2022. Because of the uncertainty in climate projections, the level of support required for the assumption that future precipitation rates will be below the historical average for very long periods of time (e.g., up to 1,000 years) would be exceptionally high. In addition, the assumed below-historical-average precipitation rates appear to be very risk significant as they contribute to a model-projected drying of the alluvial aquifer. This drying of the alluvial aquifer essentially cuts off the plume in the alluvial aquifer from migrating toward the subcrop area with the SAG aquifer. This SAG subcrop area is located near to Milan Municipal wells.

The groundwater model appears to be very sensitive to the assumed precipitation. A comparison of the base case figures (i.e., Figure 4 and Figure 5) with Figure 6 and Figure 7, shows the impact of a slightly higher recharge rate on the drying of the alluvial aquifer. In the base case with natural attenuation, the plume is shown below in Figure 5 as being effectively cut off before 1,000 years as the leading edge of the plume migrates toward the confluence with the Rio San Jose, just upgradient from the subcrop area. However, in the higher recharge sensitivity analysis, the alluvial aquifer remains hydraulically connected to the SAG subcrop area. The NRC staff further notes that HMC's higher recharge rate, which is based in part of the annual precipitation, does not appear to capture the historic average precipitation, as observed at the Grants-Milan Municipal Airport. Figure 7 shows that the leading edge of the plume under HMC's preferred Alternative 3 (i.e., ACLs) could result in impacts to the area where the SAG is in hydraulic communication with the alluvial aquifer. Also, HMC's bounding case, which also does not adequately capture historical precipitation rates at the Grants-Milan Municipal Airport, results in a cutting off of the plume prior to the plume reaching the subcrop area, as shown in Figure 8 and Figure 9 below. Accordingly, the NRC staff is concerned that actual precipitation rates could result in substantially greater impacts than assumed in HMC's ACL application, including impacts to the regional drinking water supply aquifer.

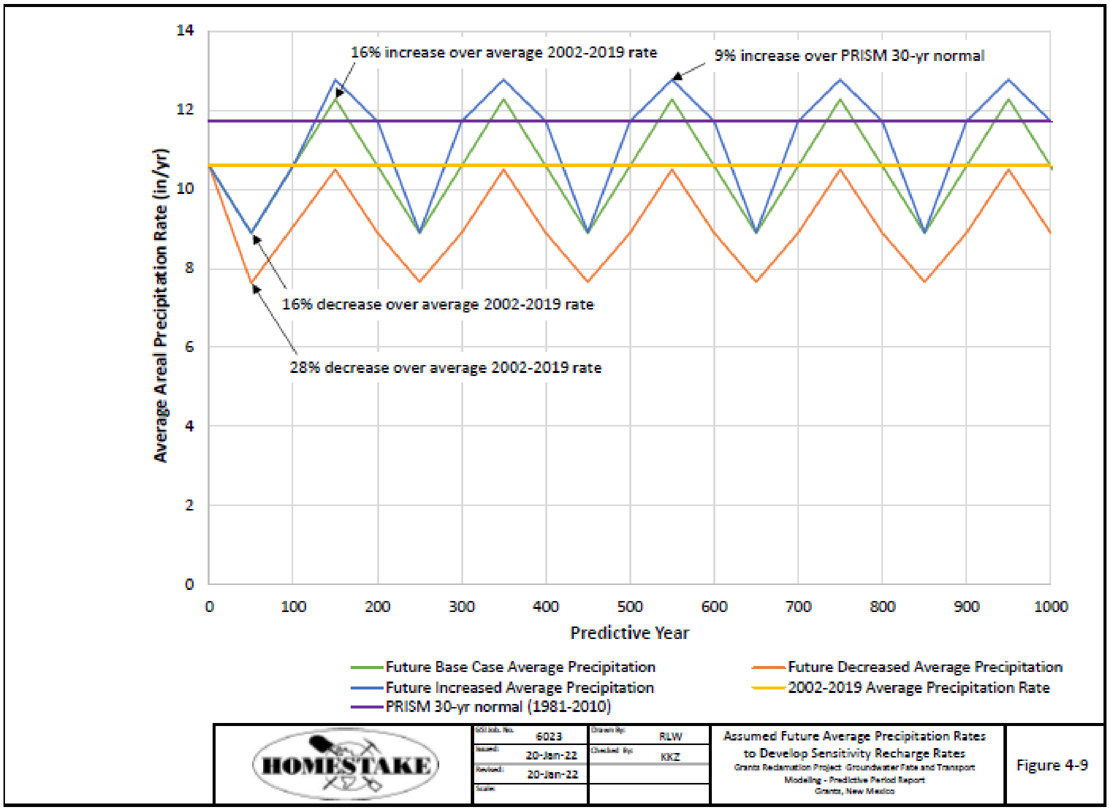

Figure 1. HMC's Projected Annual Precipitation for the GRP for the Base Case and Bounding Case (adapted from Figure 4-9 in HMC's ACL Application Appendix 4.2-B)

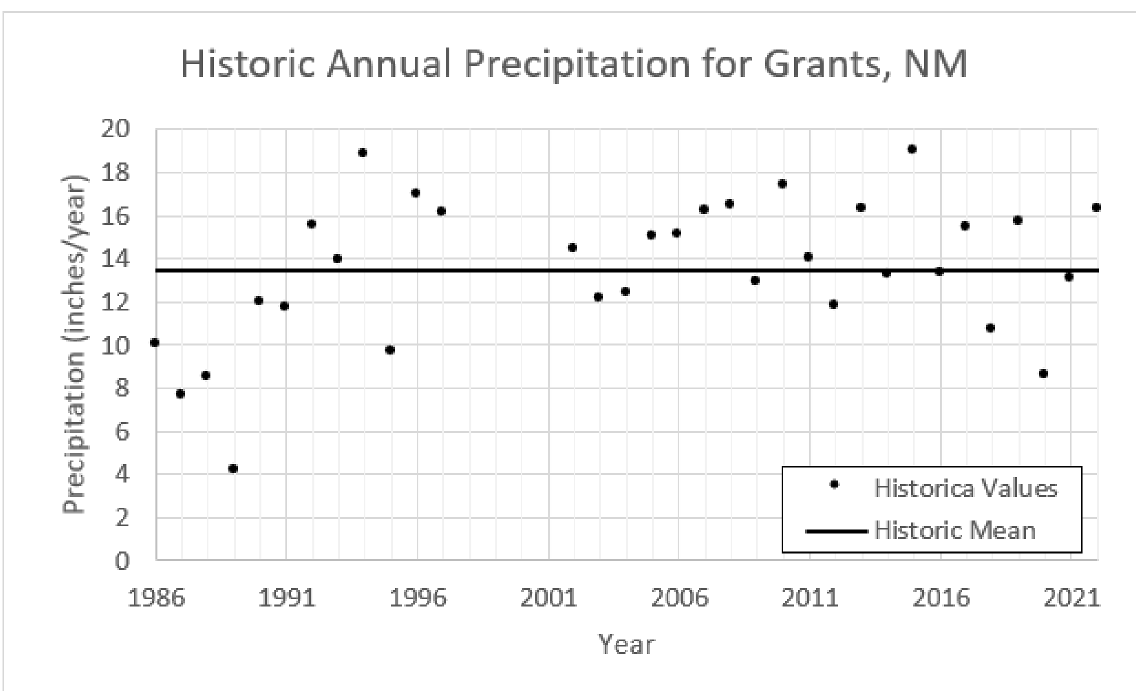

Figure 2. Historic Precipitation for Grants, NM (adapted from WRCC data for Grants, NM)

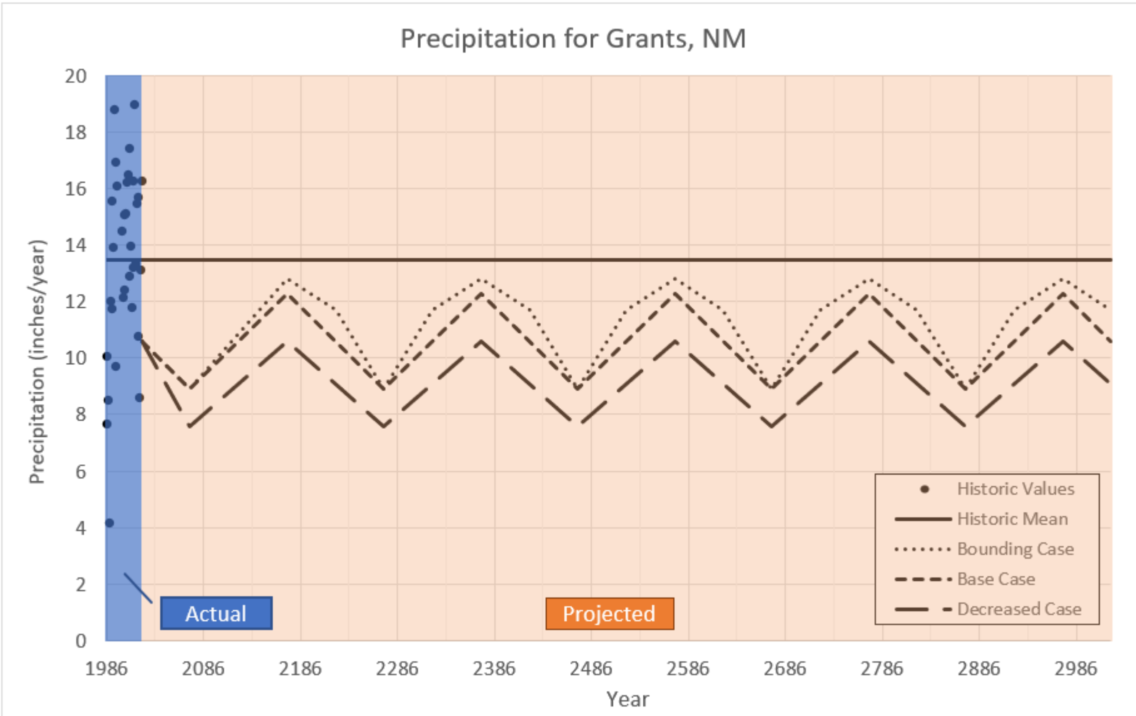

Figure 3. Historic and HMC Projected Precipitation for Grants, NM (adapted from WRCC data for Grants, NM and HMC's ACL Application)

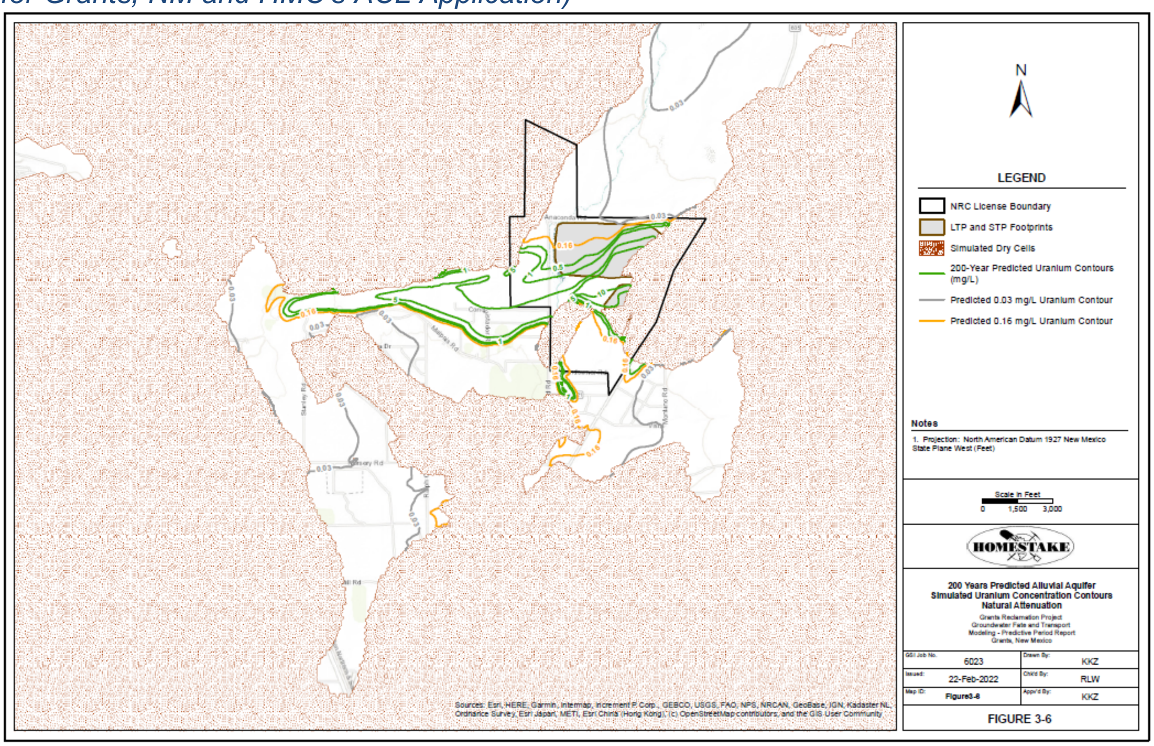

Figure 4. 200-year Predicted Uranium Concentrations for Base Case[1] (adapted from HMC Figure 3-6 of the ACL Application Appendix 4.2-B)

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[1] In Sections 1 and 4.2.4.3 of the ACL application, HMC discussed that the base case condition was developed to evaluate alternatives. Alternative 3 (i.e., ACLs) was modeled using the natural attenuation scenario.

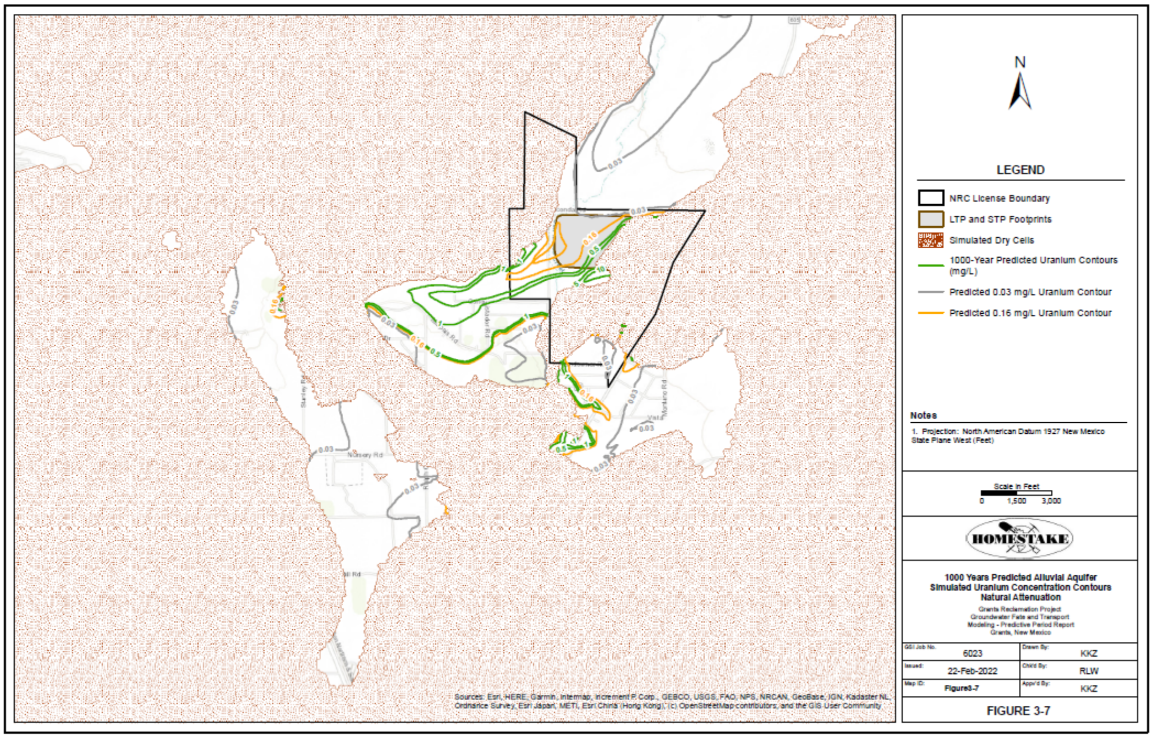

Figure 4. 1000-year Predicted Uranium Concentrations for Base Case Condition (adapted from HMC Figure 3-7 of the ACL Application Appendix 4.2-B)

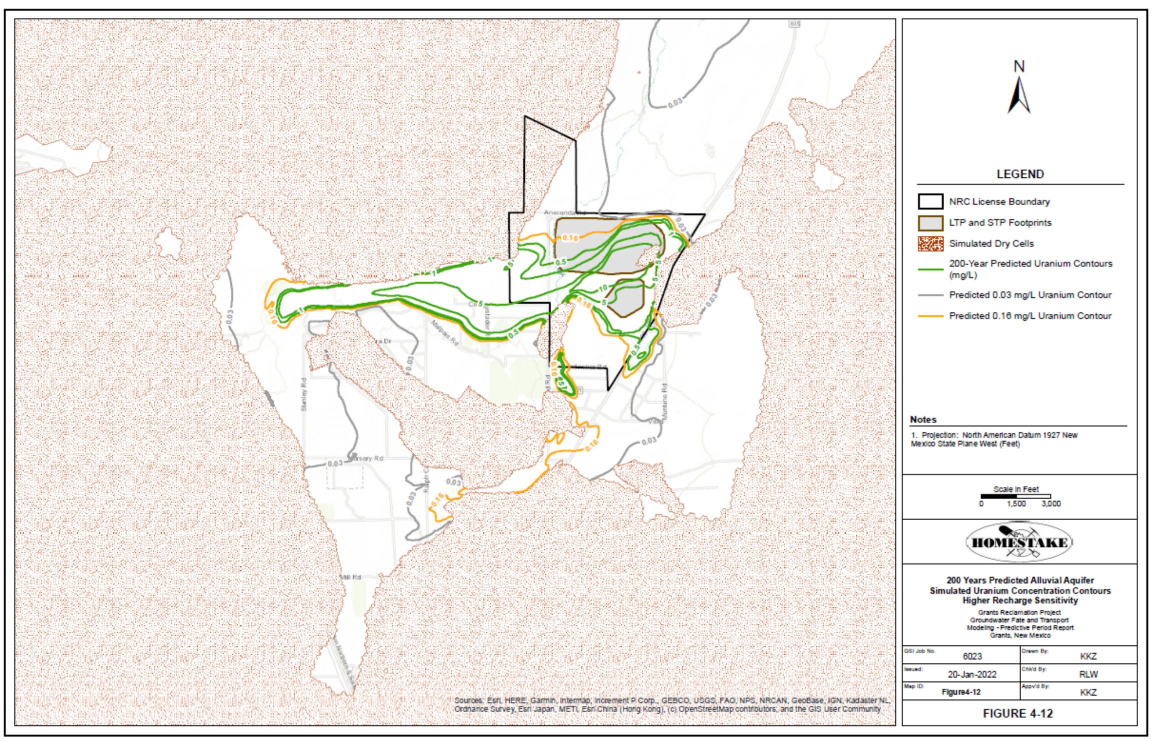

Figure 5. Sensitivity Analysis for 200-year Predicted Uranium Concentrations with Higher Recharge for the Base Case Condition (adapted from HMC Figure 4-12 of the ACL Application Appendix 4.2-B)

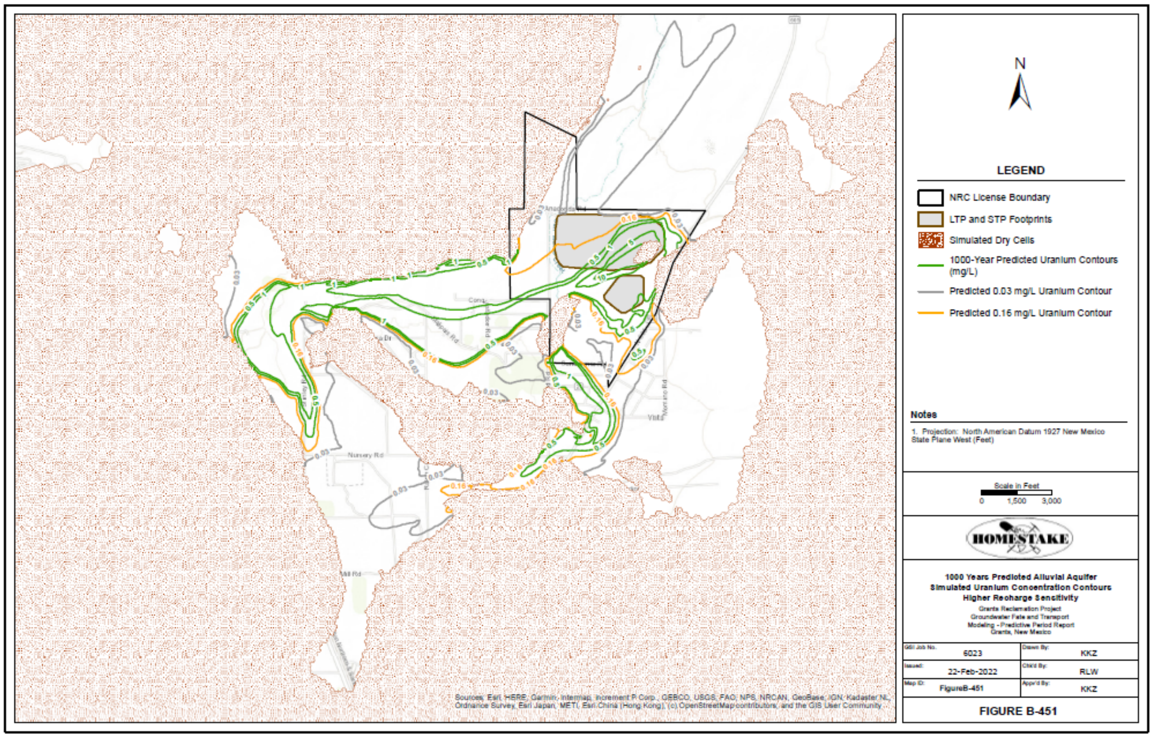

Figure 6. Sensitivity Analysis for 1000-year Predicted Uranium Concentrations with Higher Recharge for the Base Case Condition (adapted from HMC Figure B-451 of the ACL Application Groundwater Flow and Transport Modeling - Predictive Period Report)

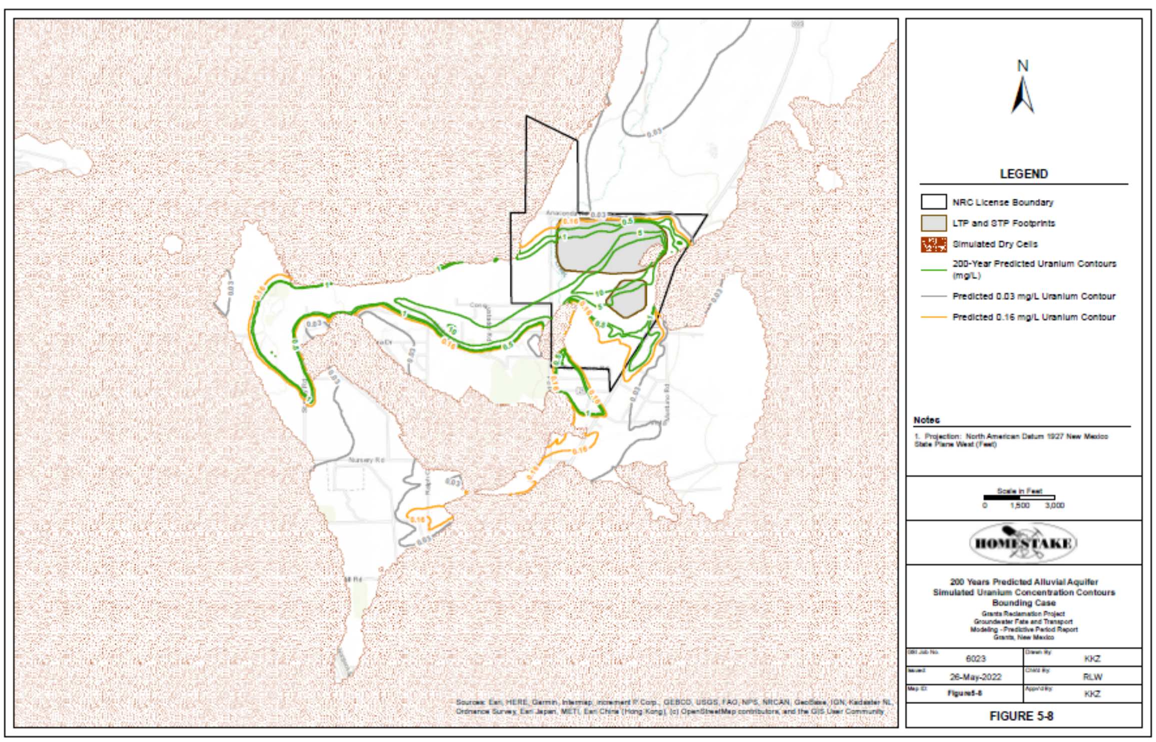

Figure 7. 200-year Predicted Uranium Alluvial Concentration for the Bounding Case (adapted from Figure 5-8 in HMC's ACL Application Appendix 4.2-B)

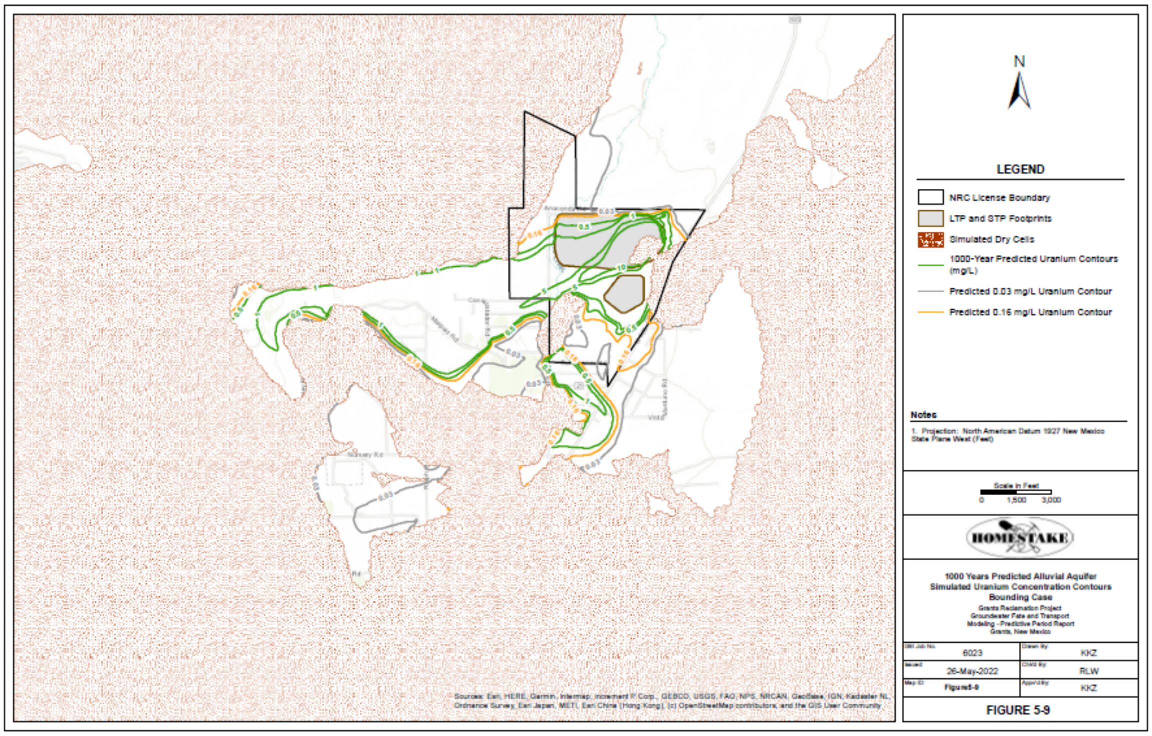

Figure 8. 1000-year Predicted Uranium Alluvial Concentration for the Bounding Case (adapted from Figure 5.9 in HMC's ACL Application Appendix 4.2-B)

Comment 1-4 (Precipitation – Episodic Events and Snowmelt)

The precipitation rate implemented in the groundwater model is unclear.

Discussion

It is not clear in the ACL application how the annual precipitation rates are applied in the groundwater model. If the precipitation is temporally averaged (i.e., applied at an annual rate or averaged monthly or daily), then recharge could be underestimated. Even though annual pan evaporation may exceed annual precipitation, episodic events and snowmelt could still result in precipitation percolating into the groundwater. Figure 10 shows the monthly precipitation rates relative to the range of modeled precipitation if the annual precipitation was evenly divided across 12 months. Daily precipitation versus an average annual precipitation would illustrate an even greater disparity. To avoid potentially underestimating recharge, there needs to be some accounting and discussion of how episodic events are addressed within the model.

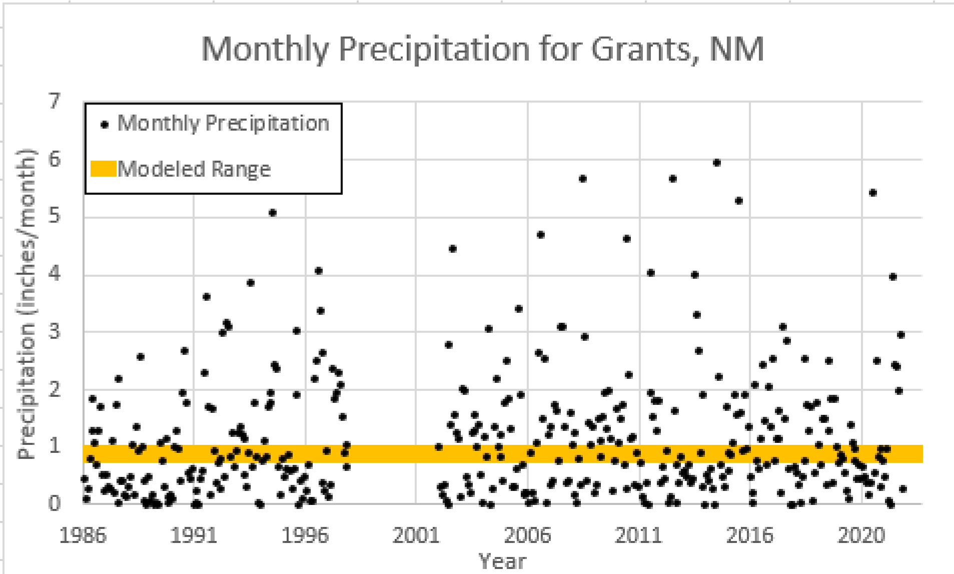

Figure 9. Historic and Modeled Monthly Precipitation for Grants, NM

Comment 1-5 (Recharge for the GRP)

The assumed recharge rate in the groundwater model for years with above-average precipitation is not well supported in the LAR.

Discussion

As discussed in Comment 1-3, the assumed precipitation and recharge rates are risk significant because of the potential for modeled drying of the cells representing the alluvial aquifer.

In Section 1.2.2.3.3 of the ACL application, HMC discussed that the annual precipitation in 2020 was 7.55 inches and the average pan evaporation is approximately 63 inches/year, resulting in an annual moisture deficit for the region. Further, in Section 4.4 of the Groundwater Flow and Transport Modeling – Predictive Period Report, HMC discussed that projected increases in temperatures will significantly reduce groundwater recharge. The NRC staff note that recharge can still occur in areas where pan evaporation rates exceed precipitation rates because of temporal variability and averaging. The pan evaporation is an annual average. However, precipitation is episodic and not temporally distributed evenly throughout the year, so precipitation events can exceed average evaporation rates. During these events, precipitation can result in recharge before evapotranspiration can remove all of the moisture, especially during short, intense rainfall events. Also, the evaporation rate can vary significantly throughout the year. Accordingly, precipitation in colder periods could exceed evaporation rates, which can include snow melt. Lastly, higher temperatures can result in more evaporation, but the likelihood and magnitude of significant precipitation events also increases with the increased energy and increased air moisture holding capacity associated with those higher temperatures, as discussed in Section 10 of NUREG/KM-0015.[2]

In Section 4.4 of the Groundwater Flow and Transport Modeling – Predictive Period Report, HMC discussed that base case recharge rates were assumed to be 2 percent for precipitation rates less than 8 inches/year, 4 percent for 11 to 12 inches/year, and 5 percent for greater than

[2] Agencywide Documents Access and Management System (ADAMS) Accession No. ML21245A418

12 inches/year. These recharge rates are slightly higher than assumed by Maxey and Eaken[3] (1949), which was cited by HMC, for precipitation rates of less than 12 inches/year. However, for precipitation rates of 12 to 15 inches/year, Maxey and Eaken assumed 7 percent recharge rather than 5 percent recharge. Most significantly, Maxey and Eaken assumed for precipitation rates of 15 to 20 inches/year that 15 percent would be recharge. The NRC staff review found that 14 of the last 33 years had precipitation rates exceeding 15 inches/year, based on the nearby Grants-Milan Municipal Airport.

Uncertainty in the recharge rate has a significant impact on the model results because potential plume migration towards the POE, and, in association with the uncertainty of other model input parameters, may lead to non-compliance with Criterion 5B(6). The NRC staff is concerned that recharge could be underestimated by assuming below-average precipitation and excluding higher precipitation years. Accordingly, the groundwater model could underestimate plume migration and risk.

Comment 1-6 (Percolation Through Large Tailings Pile [LTP])

The assumed percolation rate through the LTP is not well supported in the LAR, considering events such as episodic events and snowmelt.

Discussion
In the ACL application, HMC appears to have assumed a percolation rate of 1.5 mm/year and 6 mm/year for the base case and bounding case conditions, respectively.[4] By letter dated September 28, 2022,[5] the NRC staff provided comments on HMC's License Amendment Request for an evapotranspiration cover. In the letter dated September 28, 2022, the NRC staff requested additional information related to percolation through the cover. Support could include lysimeter data from a test cover, lysimeter data from the actual cover with a monitoring period sufficient to capture at least the near-term percolation and pedogenic processes, and/or data from similar covers in similar climates.

Comment 2-1 (LTP Seepage Rates)

The assumed contaminant flux from the Drain Down Model for the LTP needs additional support with longer-term monitoring results.

Discussion
In Section 4.5.1 of Appendix 4.2-B, HMC discussed that the baseline Drain Down Model seepage rates were not predicted to be a significant contributor of uranium mass to the alluvial aquifer in the future. However, it is plausible that the flux from the LTP could be greater than assumed in the ACL application. For example, it took approximately 10 years for several contaminant concentrations to reach steady-state conditions during the LTP flushing program. Because the flushing program ended less than 10 years ago, steady-state conditions may not have been achieved at this time and tailings concentrations could still rebound. Additional data may be needed to demonstrate that LTP seepage rates have stabilized and rebound will not occur.

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[3] ADAMS Accession No. ML033140348

[4] The percolation rates of 1.5 mm/year and 6 mm/year were calculated by the NRC staff based on HMC's assumed seepage rates of 0.6 gpm and 2.4 gpm for the base case and bounding case conditions, respectively, and an areal extent of the LTP of approximately 810,000 m^2.

[5] ADAMS Accession No. ML22256A283

Comment 3-1 (Dual Domain/Low-Permeability Zone Characterization)

The low-permeability zones, which appear to control the long-term uranium groundwater concentrations, are not adequately characterized in the LAR.

Discussion

The low-permeability zones in the alluvial aquifer appear to control the long-term uranium groundwater concentrations based on a comparison of the base case (Figure 4), Back-Diffusion Only Source (from the low-permeability zones) Sensitivity Analysis (Figure 11), and the LTP Seepage Source Sensitivity Analysis (Figure 12). HMC discussed that sensitivity analyses indicated that model results were not sensitive to model parameters related to low-permeability zones. However, several model assumptions (e.g., alluvial cell drying) appear to obscure results from these sensitivity analyses. In other words, if parts of the alluvial aquifer are assumed to dry out and plume migration is effectively cut off, then the assumptions related to contaminant transport would not impact the model results. Because the NRC staff has concerns regarding HMC's assumptions that result in cell drying (see Comment 1-3, Comment 1-4, and Comment 1-5) and the low-permeability zones appear to control long-term uranium groundwater concentrations, the licensee will likely need additional characterization information regarding the low-permeability zones, such as:

- Characterization of the presence and distribution of low-permeability zones and high permeability zones;
- Characterization of the uranium mass and concentration in low-permeability zones;
- Characterization of the uranium concentration gradients in the high permeability zones leading to or from the low-permeability zones;
- Characterization of the physical and hydraulic properties of the high and low-permeability zones; and
- Characterization of the mass transfer rates into and out of the low-permeability zones.

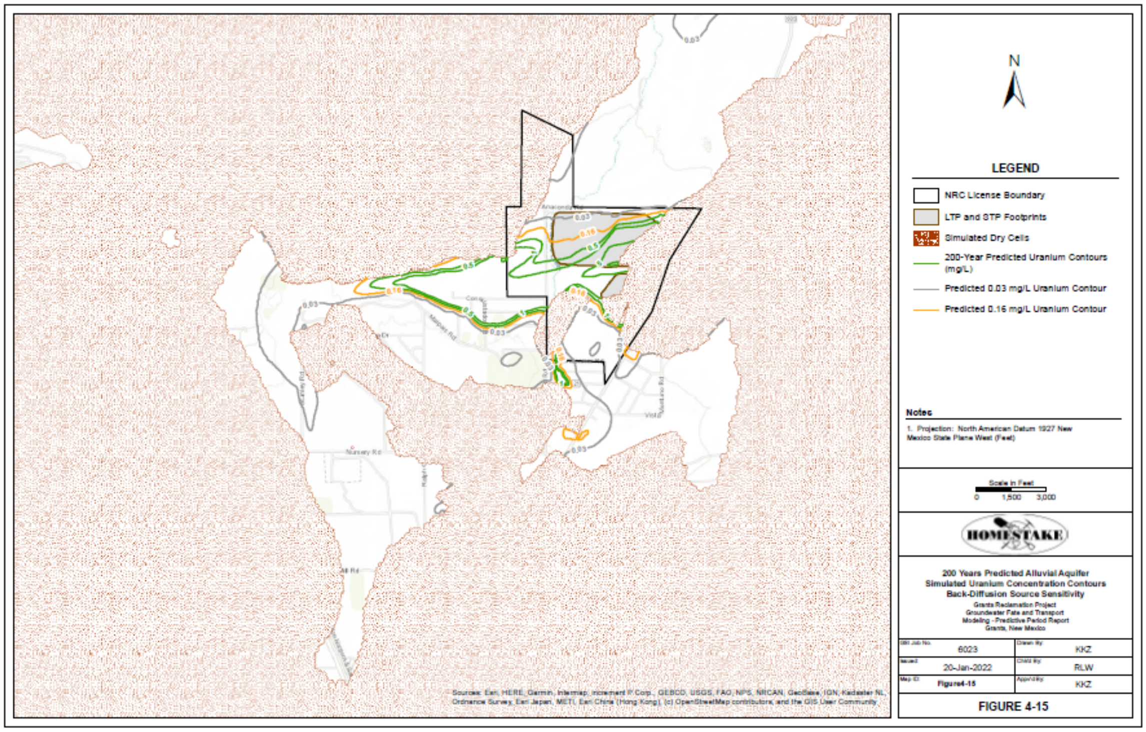

Figure 10. 200-year Predicted Uranium Concentrations for Back-Diffusion Source Sensitivity Analysis (adapted from HMC Figure 4-15 of the ACL Application Appendix 4.2-B)

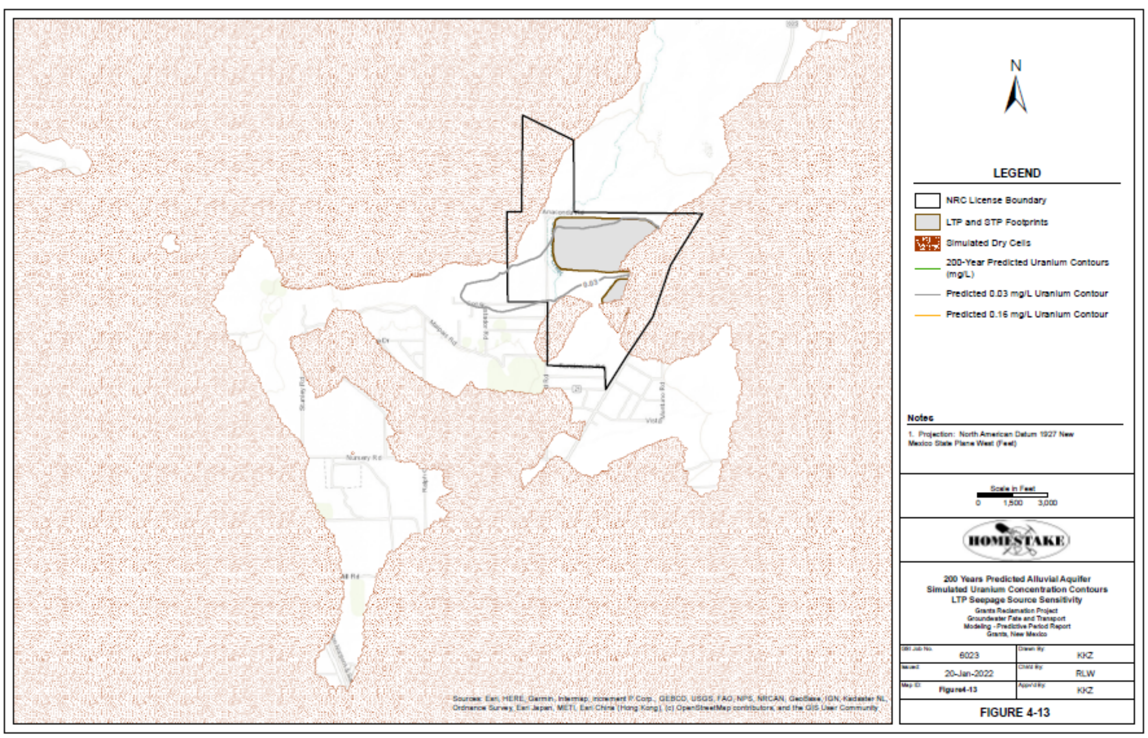

Figure 11. 200-year Predicted Uranium Concentrations for LTP Seepage Source Sensitivity Analysis (adapted from HMC Figure 4-13 of the ACL Application Appendix 4.2-B)

Comment 3-2 (Geochemical and Fate and Transport Modeling)

The methodology used for calculation of the proposed values for the ACLs may require additional basis and discussion, which may include:

a. The corresponding model-predicted impacts at the POE's may need to be adjusted, if the maximum observed value is used as the ACL which is greater than the impacts predicted by the model;
b. The possible analysis error resulting from using background in the attenuation factor analyses that will likely be conservative as proffered by the applicant (i.e., the calculated attenuation factor is lower than the actual attenuation factor) will need further discussion;
c. Further explanation is required as to why POEs are located "along principal transport paths at points where predicted solute isoconcentration contours were the closest to the control boundary" and why POE concentrations were not evaluated in the centerline of the plume;
d. The possible bias in the maximum POE concentration due to the POE location becoming dry during the simulation or the intervening alluvial aquifer becoming dry during the simulation impeding the horizontal plume migration will need further discussion; and
e. The applicant will need to demonstrate that well SZ is representative of groundwater flow through the alluvial aquifer at the proposed POC.

Discussion

The method for ACL calculation as proposed by the applicant consists of (1) using an attenuation factor to back calculate the ACL value for a constituent based on the model-predicted concentrations at the POE, and (2), should the value from the attenuation factor calculation be less than the current maximum value observed in the POC area, then the proposed ACL value is the current maximum value currently observed in the POC area. The constituents with a current maximum observed value above the model-predicted maximum are uranium (U), molybdenum (Mo), selenium (Se), sulfate (SO_4), arsenic (As) and boron (B). The current maximum value for U, Mo, Se, and SO_4, which are the primary drivers for this ACL application, was derived from a single well, SZ.

The attenuation factor analyses presented in the application appear to employ a sizable number of errors. First, if the maximum observed value is used as the ACL, which is greater than the impacts predicted by the model at the POC, then the corresponding model-predicted impacts at the POE's should be adjusted accordingly. For example, if corrected by simple scaling, the maximum uranium concentration at POE-9 would be 0.0445 mg/L (0.0225 X 1.976) rather than the model-predicted concentration (i.e., 0.0225 mg/L) using a scaling factor of 1.976 ((57.7 mg/L (Proposed ACL) / 29.2 mg/L (maximum model-predicted concentration)). Such a POE concentration exceeds the uranium Maximum Contaminant Limit (MCL) of 0.03 mg/L, which would be the appropriate standard for uranium at the proposed POE location.[6]

Second, the attenuation factor values are based on POE concentrations of +/- 0.02 mg/L. However, those values are likely the model-assumed background of 0.02 mg/L with a variation due to numerical dispersion (inherent in modeling software) or mixing with recharge with a model-assumed concentration of 0.01 mg/L rather than due to the plume migration. While using background in the attenuation factor analyses will likely be conservative as proffered by the

[6] The applicant uses a background value of 0.16 mg/L for the POE locations. However, that background value was approved for the tailings impoundment location. The POE locations are several miles from the tailings and the background value for the tailings pile location is not appropriate.

applicant (i.e., the calculated attenuation factor is lower than the actual attenuation factor), the analysis is in error and should be discussed.

Third, the attenuation factor methodology is most appropriate when the POC and POE are on the centerline of plume migration and both have been affected by the plume major attenuation processes. Away from the centerline, the attenuation factor may be more of a factor of transverse dispersion rather than the primary advective process of adsorption. For example, if the POE location is not affected by the plume, then a calculated attenuation factor value would approach infinity as the impacted concentration at the POE is zero (the attenuation factor is the concentration at the POC divided by the concentration at the POE). The application states that the POE are located "along principal transport paths at points where predicted solute isoconcentration contours were the closest to the control boundary." The applicant should have considered the concentrations in the centerline. Unfortunately, based on the model-predicted water table contours, the NRC staff anticipates that no plume centerline crosses the long-term control boundary. As such, any elevated concentration in the source area would be acceptable even without any corrective actions which is contrary to the requirements for an ACL to be as low as is reasonably achievable (ALARA).

Fourth, the maximum POE concentration may be biased because the POE location becomes dry during the simulation or the intervening alluvial aquifer becomes dry during the simulation impeding the horizontal plume migration. For example, the maximum model-predicted concentration in Layer 1 (alluvium) at the POE-11 location is 0.014365 mg/L. However, that concentration is observed during the 5th stress period (5th year after cessation of the corrective actions) and the cell, which is alluvium, becomes dry thereafter. The NRC staff does not expect that the plume would reach the location of POE-11 within 5 years and such a comparison is not technically appropriate.

Fifth, a constituent concentration based on the current observed maximum levels at well SZ is not likely representative of groundwater flow through the alluvial aquifer at the proposed POC. Historically, the concentrations of all constituents at well SZ have been elevated and more consistent with the 1980's tailings liquid quality rather than that of the alluvial aquifer. The NRC staff assumes this concentration is a relict when tailings fluid spilled into the aquifer and, at this location, the strata had a high affinity to sorb the constituents. If correct, such strata would not yield sufficient flux to the aquifer to significantly contribute to the plume quality downgradient of the POC. The applicant has not provided a boring log for this well or other tests to better define its role as a POC well. It should be noted that a conclusion similar to staff's assumption that well SZ is not representative of the aquifer was reached by the licensee in evaluating water levels during aquifer testing/monitoring.[7]

Comment 3-3 (Geochemical and Fate and Transport Modeling)

The model appears to artificially isolate the SAG aquifer from the alluvium that will require further explanation in the LAR.

Discussion

The model appears to artificially isolate the SAG aquifer from the alluvium by:

[7] ADAMS Accession No. ML20203K211

1. Assigning a low hydraulic conductivity to the top 20 feet of the SAG. A low conductivity to the uppermost limestone (San Andres Formation) would limit the infiltration to the underlying portion of the SAG (Glorieta Sandstone). On the other hand, data from two irrigation wells within the control boundary suggest the upper limestone (San Andres Formation) is highly permeable with driller yield estimates of 1000 gallons per minute. In addition, the Hydrogeologic Conceptual Site Model Report (Appendix A of the ACL Model Calibration Report) list the San Andres Formation as highly permeable.

2. Assigning a General Head Boundary (GHB) in the southeastern corner of Layer 2 that effectively lowers the potentiometric surfaces for layers 3 through 9 (Chinle) but not in layers 10 and 11 (SAG). The reference head in a GHB in Layer 2 is 6019.6 ft-MSL. For comparison, the reference head in the GHB in Layer 11 at the same location is 6379.95 ft-MSL. The GHBs in Layer 2 may be artificial.

3. Assigning an extremely low hydraulic conductivity to the Chinle shales. The hydraulic conductivities assigned to the Chinle shales (layers 3, 5, 7, and 9) are from 2.5e-4 to 1.0e-3 feet per day. Within the control boundary, even at the assigned low hydraulic conductivities, some impacts are reaching the SAG. In the southern area of the alluvium where the alluvium directly overlies the San Andres, the impact to the SAG would be more significant due to the lack of an intervening Chinle Formation if the plume migrated into this area.

Comment 3-4 (Geochemical and Fate and Transport Modeling)

The model predicts the SAG aquifer is dry in the area west of Route 122 that appears to be contrary to the conceptual model of recharge to the SAG along the northwestern flanks of the Zuni Mountain.

Discussion

The model predicts the SAG aquifer is dry in the area west of Route 122. This prediction is based on a thickness of the SAG of 350 feet and may or may not be correct. The prediction, however, is contrary to the conceptual model of recharge to the SAG along the northwestern flanks of the Zuni Mountain (see Figures 23 and 24 in the Licensee's San Mateo Creek Basin and HMC Hydrogeologic Site Conceptual Model[8]).

It is possible that lowering of the SAG potentiometric surface by 40 feet during the previous 30 years may have resulted in drying of the recharge area. However, the New Mexico State Engineer database lists a well (B-01898) completed in 2015 near the location of the southwestern boundary of the modeled area. The well has a depth to water of 300 feet and a depth of 400 feet, which the driller described as limestone and sandstone. The surface elevation at this location is estimated by staff at 7000 ft-MSL. This information can be interpreted that the Glorieta is partially saturated though the potentiometric head is significantly higher than that measured in the Rio San Jose valley.

Comment 3-5 (Geochemical and Fate and Transport Modeling)

The assumptions and parameters used for Layer 2 of the model are not well supported and will likely require additional basis.

[8] ADAMS Accession No. ML22263A396

Discussion

The regional model may be unduly influenced by assumptions for input parameters needed for Layer 2. Layer 2 represents the undifferentiation of bedrock units younger than the Chinle Group. The units include the Jurassic- to Cretaceous-age Entrada Formation, Todilito Limestone, Summerville Formation, Bluff Formation, Morrison Formation, Dakota Sandstone, Mancos Shale, Gallup Formation, Crevasse Canyon Formation, and the Menefee Formation. The model assigns a single hydraulic conductivity of 0.1 feet per day except in the southeastern corner where the hydraulic conductivity is increased to 1.0 feet per day (this is the area with the GHB noted above). In addition to the boundary conditions noted above, this layer also has cells with substantial thicknesses (up to 6549.2 feet). There are no monitoring points nor targets in the model Layer 2.

The application does not reference the source of information on Layer 2 hydraulic properties but states that the GHBs in Layer 2 were "developed using published groundwater-level contour maps" for several units "as presented and discussed in the Work Plan (HMC 2018 a)." The specific reference is a 60-page Groundwater Flow and Transport Modeling Work Plan which staff assumes is the Agencywide Documents Access and Management System document dated March 2018.[9] The plan includes only one regional schematic map. Several published maps are included in the applicant's report entitled "San Mateo Creek Basin and HMC Hydrogeologic Site Conceptual Model Conceptual Site" which would be a better reference.

By letter dated March 4, 2019, the licensee submitted a "Preliminary Groundwater Flow and Transport Model Status Report."[10] In that report, the licensee stated that an initial attempt to produce an 18-layer model in which the various units within Layer 2 were segregated into individual layers proved to be difficult. As a result, that model presented in 2019 was reduced to 10 layers, in which Layer 2 represented the undifferentiated bedrock units above the Chinle Group similar to the current model in the 2022 ACL application.[11] However, in the 2019 model, Layer 2 only had one hydraulic value of 0.04 ft/day and a reference head of 6320 ft-MSL for GHBs in the southwestern corner, both of which differ from those values in the current model. The licensee did not provide the rationale for the change in the application.[12]

Comment 3-6 (Groundwater Well Permits)

a. The LAR should include a buffer area outside of the proposed control boundary that may provide groundwater within the control boundary.
b. The groundwater wells within the buffer area should be identified.

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[9] ADAMS Accession No. ML18093A641
[10] ADAMS Accession No. ML19071A309
[11] The NRC staff notes that the 2019 Model had 10 layers compared to 2022 ACL application model having 11 layers. The difference is that the top 20 feet of the SAG has be segregated.
[12] In addition to the changes in Layer 2, the 2019 version included stream boundary conditions in Layer 1 to simulate flow in the Rio San Jose near Grants, New Mexico, which were eliminated from the 2022 model. The NRC staff reviewed USGS stream information from former stream gaging station on the Rio San Jose near Grants (USGS 08343000) and the data appear to reflect an intermittent rather than ephemeral stream. As such the applicant should discuss why the stream boundaries were removed.

Discussion

The applicant identified 23 non-HMC permits for private wells (Figure 1.2-57, Table 4.4-1 and Appendix 4.4-A). The NRC staff reviewed the New Mexico Office of the State Engineers Geographical Information Systems for the registered Points of Diversion and identified several registered diversions listed as active but not included in the 23 applicant identified wells. It is unknown if those wells did not meet other applicant search criteria (e.g., on land not controlled by HMC). Furthermore, a survey should include a buffer area as well outside of the proposed control boundary that may provide water at a point of use within the proposed control boundary. The licensee did not provide a full record of all active registered diversions within the control boundary (and buffer area), all active points of use within the control boundary, and those active permits owned by Homestake.

Comment 4-1 (ALARA)

Assumptions in the ALARA analysis require additional support and basis, including:

a. Impacts from contaminants at the POE that exceed the MCLs or background standards for contaminants based on the proposed control boundary;
b. A recalculation of the cost benefit analysis based on a revised groundwater model that considers the likelihood of the alluvial aquifer not drying out based on the effects of climate change that are highly uncertain;
c. Possible impact to the SAG aquifer that may affect a larger population than analyzed in the LAR;
d. Supplemental information regarding consequences to future generations, and
e. A demonstration that contaminant removal is ALARA considering practicable corrective actions.

Discussion

In Appendix 4.4-B, HMC discussed the potential radiological dose benefit from groundwater use at the GRP with respect to the approved groundwater protection standards and that no constituent concentrations exceed the groundwater protection standards beyond the points of compliance. The NRC staff notes that the groundwater protection standards are based on the approved background concentrations for the GRP. However, the NRC has not determined background conditions or established groundwater protection standards beyond HMC's licensed boundary. Accordingly, HMC should evaluate impacts from any contaminants that exceed the MCLs.

In the ACL application, HMC referred to NUREG 1757 Vol.2, Rev.1, which discussed that an alternative is not reasonably achievable if its costs are more than one order of magnitude greater than the monetized benefits of additional reduction. HMC provided a cost benefit analysis in Appendix 4.1-A to address the direct and indirect costs and benefits of groundwater corrective action alternatives. HMC concluded that Alternative 1 (i.e., Removal and Containment or No Action) and Alternative 2 (i.e., Removal and Containment with a Permeable Reactive Barrier) were not reasonably achievable because the costs exceeded the benefits by more than one order of magnitude. The costs for Alternative 3 (i.e., ACLs) were less than one order of magnitude greater than the benefits. Accordingly, HMC proposed the use of ACLs with Alternative 3. The NRC staff has several concerns related to HMC's cost benefit analysis.

The NRC staff is concerned that HMC's cost benefit analysis relies on a groundwater model that may not be technically defensible. The NRC staff identified concerns with assumptions regarding precipitation, recharge, and drying of the alluvial aquifer (see Comment 1-3, 1-4, 1-5), as well as other assumptions related to the geochemical fate and transport modeling. Because assumptions within the groundwater model effectively preclude contamination from migrating toward the assumed points of exposure, the potential benefits of additional groundwater remediation are obscured.

For the calculation of benefits, HMC assumed that the affected population would be 57 people across an area of 9.7 square miles, based on institutional controls limiting access to potentially contaminated land and groundwater. However, HMCs ALARA analysis raises three key concerns that were not fully explained: (1) anticipated plume expansion and migration, including the plume in the alluvial aquifer (2) plume migration toward the area where the alluvial aquifer is hydraulically connected to SAG aquifer (observed as a depression in isopleth contours for the alluvial aquifer potentiometric surface in the vicinity of the southwestern corner of Township 12N, Range 10W Section 33 on ACL application Figure 1.2-29), and (3) the SAG being the drinking water resource for the region. The NRC staff is concerned because even a minor increase in contamination to the SAG aquifer could result in significant impacts due to the number of people potentially impacted. The number of affected people could increase by multiple orders of magnitude greater than assumed by HMC if the SAG becomes impacted. Accordingly, consideration of additional groundwater restoration could be cost effective depending on key assumptions and the validity of HMC's groundwater model.

In addition to potential contamination of the SAG and the associated health impacts, there could be environmental impacts. HMC calculated the costs of an alternative water supply. However, there is no known alternative water supply for the SAG. HMC qualitatively discussed land value depreciation based on the three alternatives. However, HMC did not include loss of land value due to potential impacts to the SAG with the consideration that the SAG is the regional drinking water resource. The NRC staff will need to have confidence that milling activities at the GRP will not impact the SAG aquifer. The determination of the practicability of corrective actions requires a defensible groundwater model.

The NRC staff appreciates that there are diminishing returns over time with continuing groundwater restoration corrective action. However, HMC's ACL application shows that a significant amount of uranium continues to be removed from the groundwater at nearly a linear rate, as shown by the green line in Figure 13 below. Furthermore, the onsite groundwater collection rate, which is shown by the gray line in Figure 13 below, has been operated at or below 300 gpm on an annualized average rate for approximately 11 years between 2005 and 2015. During that time, the Reverse Osmosis (RO) capacity was 600 gpm as stated in Section 4.1.3.2 of the LAR. In 2015, the RO system was upgraded and reached a design capacity of 1,200 gpm, however, after a rapid collection rate increase in 2016 to nearly 600 gpm, the collection rate again has rapidly declined to approximately 300 gpm in 2019, as shown in Figure 13. Operating the RO system corrective action at approximately one-half of its capacity for an extended period of time from 2005 to 2015 would have likely hindered removing uranium and other contaminations to the extent practicable and to ALARA. Operational declines after the RO system capacity peaked in 2016 does not support that the RO plant corrective action was operating to remove contaminants at the extent practicable and to ALARA. A defensible groundwater model could indicate that additional groundwater corrective actions are cost effective.

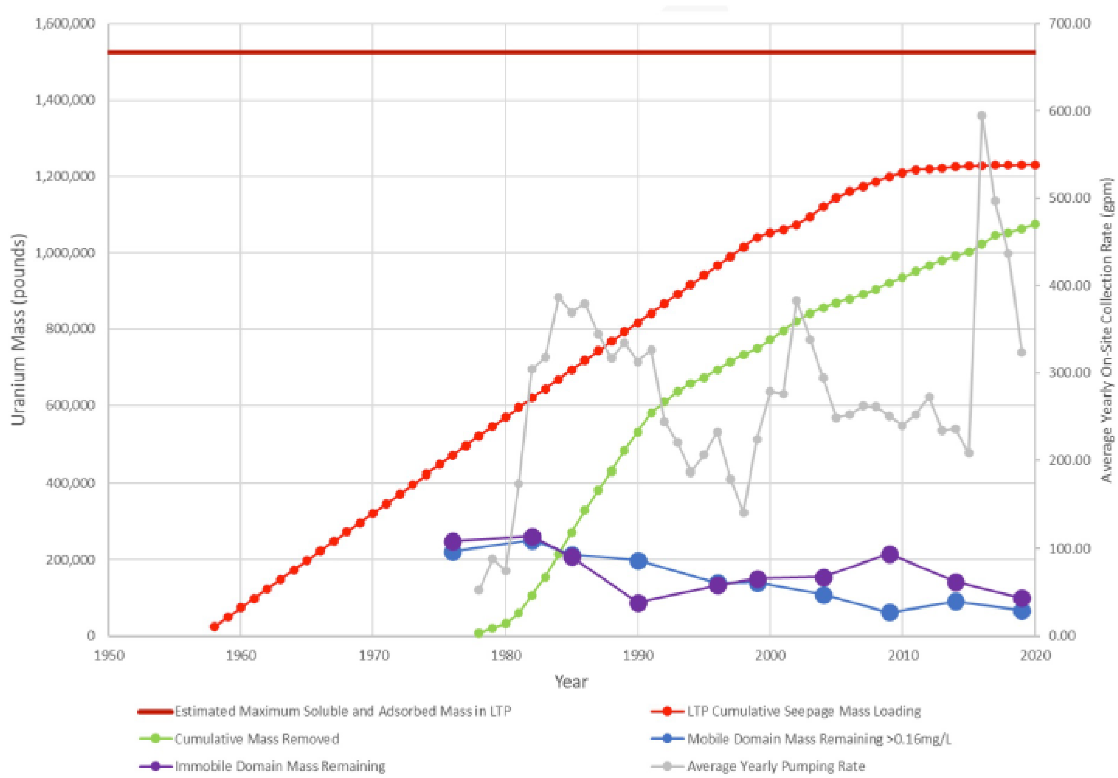

Figure 12. Uranium Mass Balance (adapted from Figure 4.1-37 in HMC's ACL Application)

In Appendix N of NUREG 1757 Rev. 2, Vol. 2,[13] the NRC staff stated that "…if licensees anticipate important intergenerational consequences, such as for cases with radionuclides with half-lives of decades or longer, licensees should consider supplementing the analysis with an explicit discussion of the intergenerational concerns, such as how future generations will be affected by the regulatory decisions."

In Section E.2.5 of NUREG/BR-0058, Rev. 5 Appendix E,[14] the NRC staff states:

For certain regulatory actions, such as those involving decommissioning and waste disposal issues, the regulatory analysis may have to consider consequences that can occur over hundreds, or even thousands, of years. The Office of Management and Budget [OMB] recognizes that special considerations arise when comparing benefits and costs across generations. Under these circumstances, OMB continues to see value in applying discount rates of 3 and 7 percent. However, ethical and technical arguments can also support the use of lower discount rates. Thus, if a rule will have important intergenerational consequences, the analyst should consider supplementing the analysis with an explicit discussion of the intergenerational concerns such as how future generations will be affected by the regulatory decision. Additionally, supplemental information could include a presentation of the costs and benefits at the time in which they are incurred with no present-worth conversion (e.g., no discounting). In this case, no calculation of the resulting net cost should be made. Also, the analyst should consider a sensitivity analysis using a lower, but positive, discount rate.

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[13] ADAMS Accession No. ML22194A859
[14] ADAMS Accession No. ML17100A612

Accordingly, the LAR should include information regarding consequences to future generations.

Comment 5-1 (Monitoring of Key Performance Indicators)

The LAR provides limited information regarding the monitoring of key performance indicators to provide model confidence and help ensure protection of public health and safety.

Discussion

In the ACL application, HMC is relying on several mechanisms and assumptions to ensure protection to public health, safety and the environment. The NRC staff have several comments and concerns related to these mechanisms and assumptions, including institutional controls to limit potential receptors (Comment 1-1); precipitation and recharge (Comments 1-3, 1-4, and 1-5); groundwater modeling (Comments 3-2, 3-3, 3-4, 3-5), and characterization of the low-permeability zones (Comment 3-1). These mechanisms and assumptions are risk significant and uncertain.

As part of the GRP corrective action program, injection wells have been used to create a hydraulic barrier and to facilitate groundwater restoration. With the proposed cessation of corrective actions, this hydraulic barrier would subside, the hydraulic gradient would revert toward pre-milling conditions, and contaminants would be able to migrate downgradient.

In Section 5 of the ACL application, HMC discussed that a comparison of measured values to proposed ACLs and predicted maximum concentrations at intermediate monitoring locations will allow verification that groundwater constituent concentrations will remain protective at the POE. The NRC staff agrees that monitoring data can be used to provide model confidence, especially for risk significant sites and sites with significant uncertainty. However, the ACL application is not clear on what key performance indicators should be monitored, the period of monitoring necessary to achieve confidence in the modeling results, and when the model should be revised.

The NRC staff notes that the following key performance indicators would reduce uncertainty and provide additional model confidence:

- Groundwater monitoring results during the near term to evaluate model assumptions, including sorption, dilution/dispersion, and effects from low-permeability zones
- Lysimeter data from a test cover or emplaced cover to evaluate infiltration, percolation, evapotranspiration, and runoff
- Longer-term tailings seepage monitoring to evaluate potential contaminant rebound and seepage rates
- Longer-term tailings elevation monitoring to evaluate potential subsidence as the tailings drain